Predict and Prevent Bullying via Technology

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ABSTRACT
Bullying in schools is spreading like cancer and there is an immediate need to predict and prevent bullying. The paper discusses the project undertaken to research the phenomena of predicting and preventing bullying via technology in K-12 education. The predictive bullying data for the research was obtained from publicly available US education department databases and other sources. The data for both traditional bullying and cyberbullying was examined for school enrollment demographics, personal characteristics of students who were bullied and perpetuators. Valid predominant values for predictors such as race, gender, locale, enrollment size and household income were identified. The implications of these findings are used to provide design recommendations for technology solutions and prevention strategies that use technology. The research addresses the question of whether combining predictive bullying data and personal characteristics of students to tailor bullying prevention programs and solutions using technology at schools will increase the chances of successfully predicting and preventing bullying.

Author Keywords
Bullying; Cyberbullying; technology solutions, prevention strategies; traditional bullying; victims; perpetuators; predictors; predictive bullying data; bullying technology design recommendations.

ACM Classification Keywords
H.4.m. Information Systems Applications: Miscellaneous.

INTRODUCTION
Bullying is a psychosocial problem involving the intentional, repetitive harming of another person with negative consequences for both the victim and the aggressor [1]. Predicting and preventing bullying is of utmost importance given the nature of consequences that results from bullying. It is a complex phenomenon encompassing personality, background of those involved, and contextual factors [1]. Cyberbullying has the same risk factors found in traditional bullying but in addition it has other risk factors such as little control over sharing personal information [1].

There has been indications that there is a slowing of publications around bullying studies and there is a need for scientific evidence-based additional research, especially in data collection, evaluation, developmental understanding, and prevention [2]. Research opportunities exist to examine causes for bullying, developing means via technology for early identification, and plan for interventions that will target students at risk for getting involved in bully-victim problems [3]. Bullying prevention should be a school-wide proactive approach rather than an event-driven after-the-fact action. The results from data driven bullying predictive analytics of both traditional bullying and cyberbullying can be used to come up with technical designs that aim to prevent bullying. Devising tools that can warn schools, students, teachers, parents, and administrators about potential risk for bullying by integrating the data obtained from the research into school systems is of particular interest. The school district information and student characteristics provided during enrollment could be used to provide information online about preventing bullying and determining if a school or student is at risk.

Data from large-scale trials of comprehensive, school-wide bullying prevention and intervention programs indicate that when used as a long-term ongoing solution rather than a 'quick fix' in crisis situations, bullying behavior can be reduced significantly [4]. Much of the bullying currently is done electronically with students using computers and/or cell phones to conduct most of their communication with their peers [5]. These students will also use this technology to harass and bully others [5]. There is a clear need for more conceptual, methodological, and empirical research on the issues related to bullying [6]. Predicting and preventing bullying can go a long way in helping communities prevent bullying that may lead to suicidal tendencies, mental depressions etc.

BACKGROUND
Recent research suggests that school bullying interventions should focus on the interplay between factors such as students' family, school, and community characteristics and students' proclivity to bully others at school [7]. Research should investigate the characteristics of bullying and of victimized children that are associated with students' experience of bullying victimization [7]. It is important to understand how these factors interact with bullying and how these factors can be taken into account in order to develop better intervention programs that help to create safer school environments [7]. It is becoming increasingly clear that a more holistic approach that moves beyond the geographical

boundaries of a school may be needed to prevent school bullying [7]. Integrating tools that predict and prevent cyberbullying into online virtual environments is critical as students are more comfortable getting support online rather than talking to an adult.

This research aims to design effective school-based bullying prediction and preventive technology programs that increases the chances of preventing traditional bullying and cyberbullying. The prevention strategies and education should be computer-delivered rather than the traditional face-to-face interventions as the traditional approaches are found to be not effective.

RESEARCH FRAMEWORK

The research entailed gathering and analyzing predictive bullying data. The theoretical constructs from the analysis are used to present the research hypotheses. Technology solutions to predict bullying and prevention strategies using technology use predictors from the analysis as an input.

Research Methodology

The data collection process for the research involved gathering bullying data from several publicly available data sources. The data was examined for several direct and indirect characteristics of bullying victims and perpetrators such as sex, race, color, national origin, and disability. The data for cyberbullying was analyzed and correlated to predictors of traditional bullying such as personality traits and backgrounds to see if there is any overlap. Analysis was performed to determine correlation of student enrollment data and personal characteristics with bullying. The plan was to determine prevalent bullying predictors and then devise technical solutions that can incorporate the data into school systems to warn about potential bullying risk to schools, students, teachers, parents and administrators. Investigation into technology solutions was based on meta-analysis and ideas around potential solutions.

The data sources that were used for the traditional bullying research include:

- U.S. Department of Education's Civil Rights Data Collection (CDRC)
- National Center for Educational Statistics (NCES)

For cyberbullying, the data sources used were:

- National Center for Educational Statistics (NCES)
- Cyberbullying Research Center
- Student Reports from US Department of Education for Bullying and Cyberbullying.

Execution

Statistics on the number of students reported to have been bullied, students disciplined for bullying, enrollment statistics for school year such as enrollment by grade, race/ethnicity, gender, students with disabilities (IDEA, Section 504), and students with limited English proficiency (LEP) was used to determine the patterns and correlation to bullying. Data about personality traits of bullying victims and aggressors, internet use at schools, websites, tools, and platforms commonly used, and social interactions of individuals were collected to analyze the potential risk for cyberbullying. The results from the analysis, meta-analysis spanning multiple research studies and potential ideas were used to devise designs for technical solutions and prevention strategies using technology.

RESULTS

Results of analysis performed suggest a trend that helps select predominant bullying predictors that can be used for devising technology solutions.

Traditional Bullying

Traditional bullying analysis was conducted on data obtained for 10 school districts in the state of Georgia from Civil Rights Data Collection and US Department of Education [8]. The data included reports on victims and perpetuators of bullying. The data was analyzed for race/ethnicity, gender, students with disabilities (IDEA, Section 504), and students with Limited English Proficiency (LEP). The following conclusions can be drawn from the analysis of bullying victims' data. See Figure 1 for data that led to these conclusions:

1. Bullying victims are predominantly **female**.
2. Bullying victims predominantly belong to **African American** race/ethnicity.
3. Bullying victims among students with disabilities (IDEA) are predominantly **male.**
4. Bullying victims among students with disabilities (Section 504) are equally predominantly in both males and females**.**
5. Bullying victims among students with LEP are equally predominant in both males and females.
6. Bullying is more prevalent in students with disabilities (IDEA, Section 504) than students with LEP
7. Bullying victims under IDEA and Section 504 can be combined together and classified as "students with disabilities" as the victims under section 504 is negligible.

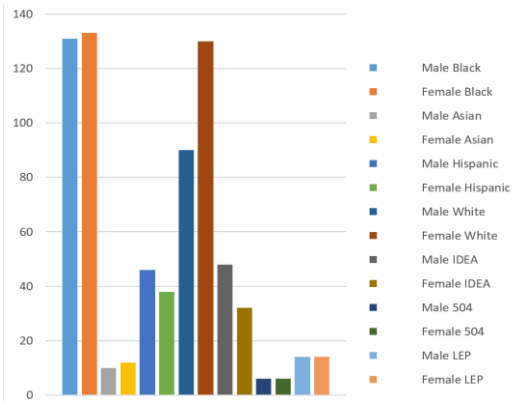

Figure 1. Traditional Bullying Victims

Analysis on perpetuators for traditional bullying yielded results noted below. See Figure 2 for data that led to these conclusions:

1. Bullying perpetuators are predominantly **male**.
2. Bullying perpetuators predominantly belong to **African American** race/ethnicity followed by **White**.
3. Perpetuators for bullying on the basis of disability predominantly belong to **African American** race/ethnicity.
4. Perpetuators for bullying on the basis of race, color or national origin predominantly belong to **White** race/ethnicity.
5. Perpetuators for bullying on the basis of sex predominantly belong to **African American** race/ethnicity.
6. Perpetuators bully more on the basis of disability than students with LEP.
7. Perpetuators bullying on the basis of disability under IDEA and Section 504 can be combined together and classified as "on the basis of students with disabilities" as perpetuators on the basis of Section 504 is negligible.

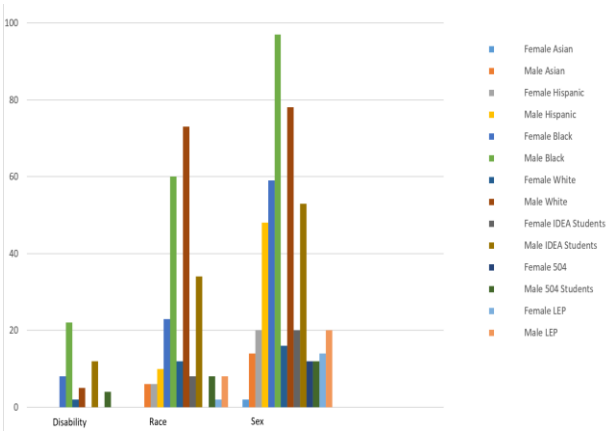

Figure 2. Traditional Bullying Perpetuators

Cyberbullying

Research on cyberbullying was performed on victims' data obtained from US Department of Education 2013 survey [9] and perpetuators' data from 2016 research article [10]. The data was analyzed for race/ethnicity and gender. See Figure 3 for cyberbullying victims' data and Table 1 for statistics based on school characteristics.

The following conclusions can be drawn from the analysis:

1. Cyberbullying victims are predominantly **female**.
2. Cyberbullying victims predominantly belong to **White** race/ethnicity.
3. Cyberbullying victims are equally predominant in both Hispanic and Asian race/ethnicity.
4. Cyberbullying is predominant in **City** and **Town** school locales.
5. Cyberbullying is predominant in **High** school students.
6. Cyberbullying is predominant in schools where the enrollment size is at least **1000** or more.
7. Cyberbullying is predominant among students who belong to households whose income is less than **$15,000**.

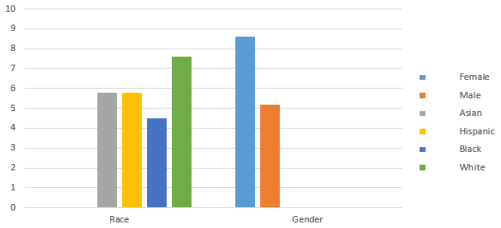

Figure 3. Cyberbullying Victims

National Center for Education Statistics for School Year 2012-2013		
School Characteristic	**Number of Students**	**Cyberbullied (%)**
Locale		
City	7,347,000	7.2
Suburb	8,035,000	6.7
Town	2,712,000	7.8
Rural	6,317,000	6.5
Level		
Primary	1,470,000	4.6
Middle	7,203,000	6.6
High	14,075,000	7.2
Enrollment size		
Less than 300	2,505,000	6.6
300-599	5,007,000	6.1
600-999	5,890,000	6.3
1,000-1499	4,387,000	7.7
1,500-1,999	2,875,000	7.0
2,000 or more	3,737,000	8.1
Household income		
Less than $7,500	919,000	9.5
$7,500-14,999	1,103,000	8.1
$15,000-24,999	1,918,000	4.9
$25,000-34,999	2,504,000	6.7
$35,000-49,999	3,269,000	6.6
$50,000 or more	10,707,000	7.4

Table 1. Cyberbullying Statistics

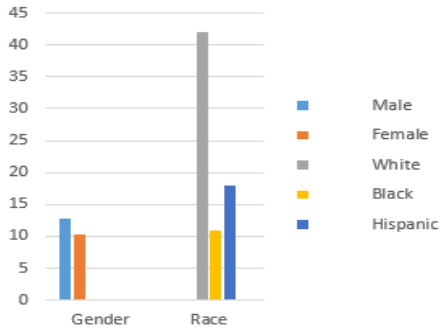

Figure 4. Cyberbullying Perpetuators

The following conclusions can be drawn from the analysis of cyberbullying perpetuators (see Figure 4):

1. Cyberbullying perpetuators are predominantly **male**.
2. Cyberbullying perpetuators predominately belong to **White** race/ethnicity

Further research was done to look for additional characteristics that could influence cyberbullying. Students with lower academic achievement were more likely to perpetuate cyberbullying [11]. Students with low academic achievement were three times more likely to be victims of cyberbullying than those with above average academic achievement [11]. It has also been observed that traditional bullying victims in a school district mostly belong to the race/ethnicity that are predominant in that school district.

Predictors

The analysis of school enrollment demographics, personal characteristics of students who were bullied and perpetuators has led to derivation of the list of predictors noted below. It takes into consideration the overlap seen in the gender for traditional bullying and cyberbullying victims and perpetuators:

- Susceptible Race = Predominant Race in the school district
- *Race*: African American and White
- *Locale*: City and Town
- *Gender for Bullying Victim*: Female
- *Gender for Bullying Perpetuator*: Male
- *Household Income*: Less than $15,000
- *School Enrollment Size*: Greater than 1000
- *Academic Achievement*: Low

DISCUSSION

A discussion around the implications of the results, design recommendations, limitations and further research is further warranted.

Technology Solutions Incorporating Predictive Bullying Data

The predictive bullying data from the results can be incorporated in technology solutions to predict and prevent bullying. Research, ideas, and meta-analysis on technology solutions has yielded the following possible solutions that can incorporate the bullying predictors:

1. *Public School Enrollment Systems:* The public school enrollment systems can incorporate the bullying predictors into the enrollment process. Upon enrollment, the student and parents could be provided with bullying risk information based on the school district that the student is enrolling in and predictors such as gender, race, locale, household income and enrollment size. For instance, the Atlanta Public Schools online enrollment system and Infinite Campus parent/student portal could be updated with bullying risk information for the enrolled student. The information can be updated periodically every school year. Students and parents could be supplied with information about ways to prevent bullying if the school or student is in a high risk area based on predictors.

2. *Bullying Risk Code Level:* Every school district can use the bullying predictors to come up with "Bullying Risk Code Level (BRCL)" to indicate the severity of bullying risk in the school district. BRCL can be incorporated into existing school systems that track student information. An advisory system can also be built for bullying in schools that incorporates BRCL. A color code indicating the severity of the risk can be devised as follows –

    - **Red** – Severe Bullying Risk
    - **Orange** – High Bullying Risk
    - **Blue** – Medium Bullying Risk
    - **Green** – Low Bullying Risk

The color code can be displayed in school bulletin boards and digital communications. This will caution students, teachers, administrators, and parents on bullying risk and take steps to prevent bullying. The schools can increase or decrease the anti-bullying monitoring needs based on BRCL and provide relevant education on prevention strategies and coping.

3. *Incident Tracking and Warning System:* An incident tracking and warning system can be built to track bullying incidents and the location of bullying. The system can incorporate bullying predictors and perform intelligent analysis based on location of bullying and predictors to warn students, teachers, administrators, and parents on bullying risk at the school.

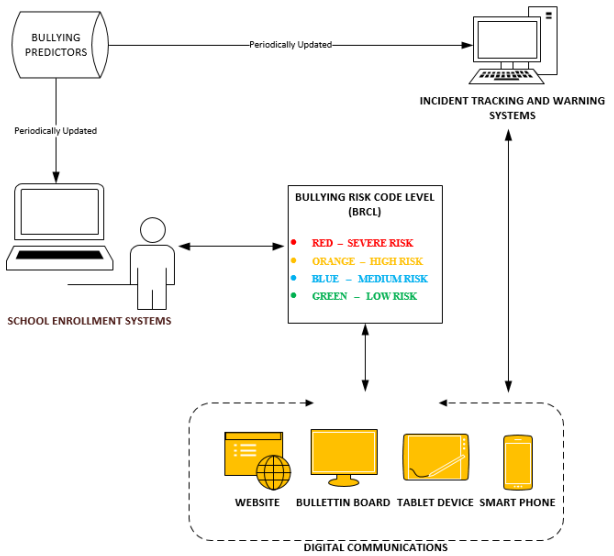

Figure 5. Technology Solution High Level Design

Figure 5 shows the high level design recommendation for the technology solution that incorporates predictive bullying data. The bullying predictors will need to be periodically updated based on research and fed into school enrollment systems and incident tracking and warning systems. BRCL code can be communicated via digital devices and bulletin boards at schools to warn students, teachers, administrators and parents on bullying risk so that they can take appropriate actions.

Prevention Strategies Using Technology

Research into bullying prevention strategies using technology has led to recommendations noted below. The recommendations are based on meta-analysis and ideas around bullying prevention using technology.

1. *Anonymous Bullying Reporting and Prevention Systems:* A system to report bullying incidents in schools can be implemented. There are several applications available for students to anonymously report bullying incidents. Students can anonymously report bullying, submit safety tips, and learn more about safety using these applications [12]. Statewide online reporting systems could be implemented as well. Anonymous reporting is found to be more successful as majority of students who report bullying are not victims, but concerned bystanders who will report bullying if given the opportunity to report in a way that doesn't compromise their own safety [13]. These anonymous reporting applications can be used to take preventative steps when active bullying is in progress.

2. *Big Data Applications:* To prevent cyberbullying, a heat map can be developed that tracks references to bullying on social networking sites and video platforms. This will help create data visualizations of where bullying occurs in the school districts [14]. The predictors for bullying can be used as input to these applications. Algorithms could be used to narrow down where bullying would occur the most on the map in specific school districts [14]. Such big data applications can be implemented in school district administration offices to monitor cyberbullying in schools. Prevention strategies can be devised by school districts based on heat maps that indicate high bullying activity.

3. *Internet Safety Systems:* Internet safety systems can be implemented in schools for cyberbullying prevention. These systems monitor internet activity by students in schools, monitor keywords used and flag vulnerable students [15]. The school administrators can monitor red flags and take action immediately. The safety systems can help prevent access to restricted sites at schools. They can monitor personal websites, blogs, email, texting, social networking sites, chat rooms, message boards, instant messaging, photographs, and videos for vulnerability [16]. To detect cyberbullying in digital platforms, the safety systems can use methods such as filtering keywords, text-based detection, participant-vocabulary consistency, text-stream detection, data labeling, analyzing comments, supervised machine-learning models, user context, online harassment classification and username detection, latent semantic indexing, and model constructed on Information and Communication Technology (ICT) features [17].

4. *Proactive Cyberbullying Prevention Applications:* Applications that prevent cyberbullying at the source can be implemented at schools. There are apps that warn the students to stop and think again before sending a message with cyberbullying content [17]. These apps could be employed by the school districts to proactively combat cyberbullying.

5. *Bullying Awareness Systems:* Education is the best medicine to prevent bullying and technology can be used to deliver educational literature and videos to increase awareness among students about bullying. The bullying awareness systems will source information from various websites, news, and media to create custom content based on bullying predictors for the school district. These systems could be implemented in schools and updated periodically with the latest information. In case of cyberbullying, this could include tips on reporting bullying, unfriending/unfollowing the person or leaving the conversation with the bully and blocking the person [17]. Educating students on resources to report to hosting companies of messaging apps, email, social networking sites and other service providers of abuse can be included in the educational material. The awareness systems can include videos of cyberbullying behaviors demonstrating the negative experiences and sad face photos of bystanders increasing empathy [17].

Limitations

The research study and analysis was conducted on a finite set of data. For analysis of traditional bullying for victims and perpetuators, the data collection was limited to 10 school districts in the state of Georgia. The data from Civil Rights Data Collection (CRDC) was based on survey conducted by US Department of Education in 2013. Cyberbullying data was obtained from the NCES and US Department of Education's results from the 2013 school crime supplement to national crime victimization survey. Perpetuators' data for cyberbullying was obtained from meta-analysis of literature around cyberbullying, race/ethnicity and mental health outcomes from 2016. Although the dataset used is limited, the analysis performed and review of prior research on bullying indicates the conclusions on bullying predictors are valid. The predictors were used to develop technology solutions that predict and prevent bullying.

The prevention strategies were mainly based on ideas and meta-analysis of literature available around the subject. Some of the applications noted in the prevention strategies are commercially available but not implemented in schools. Opportunity exists to update these applications and integrate with predictive bullying data to maximize benefit.

Further Research

Research opportunities exist to expand the data analysis using qualitative methods. The current research was performed mainly using quantitative methods. The dataset for quantitative methods can also be expanded to include data from all US states and possibly additional countries. Private and charter schools were not included in the research and that could be another avenue to address. Updated survey data when available could also be used as the source for both traditional bullying and cyberbullying research.

The designs for technology solutions and preventive strategies using technology from this research are primarily oriented towards US school systems. Further research into non-US school systems may lead to potential detailed designs that cater to developing countries and their respective school systems. The focus of this research was around the school environment. Students are vulnerable to bullying outside of the school environment such as school bus transportation systems, home, and other locations frequented by students. This opens up a myriad of opportunities for further research on bullying among students beyond the school environment.

CONCLUSION

The research study was successful in identifying predictors for both traditional bullying and cyberbullying and correlating predictors for overlaps. The predictors were incorporated into technical solutions to predict and prevent bullying. Prevention strategies using technology were also devised. The research put forth technology solutions that will help address the complex bullying phenomenon. The study asserts that combining predictive bullying data and personal characteristics of students to tailor bullying prevention programs and solutions using technology at schools will increase the chances of successfully predicting and preventing bullying.

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